THE EMOTIONAL MOTOR SYSTEM

EDITED BY

G. HOLSTEGE

Department of Anatomy and Embryology, University of Groningen, Groningen, The Netherlands

R. BANDLER

Department of Anatomy, University of Sydney, Sydney, NSW, Australia

C.B. SAPER

Department of Neurology, Beth Israel Hospital, Harvard University, Boston, MA, USA

ELSEVIER

AMSTERDAM – LAUSANNE – NEW YORK – OXFORD – SHANNON – TOKYO

1996
Contents

List of contributors........................................................................................................................................... v
Introduction........................................................................................................................................................... ix
Acknowledgements.............................................................................................................................................. xi

Section I. Introduction

1. The emotional motor system
   G. Holstege, R. Bandler and C.B. Saper (Groningen, The Netherlands, Sydney, NSW, Australia and Boston, MA, USA)............ 3

Section II. The Somatic Motor System

2. The somatic motor system
   G. Holstege (Groningen, The Netherlands).......................................................... 9

Section III. Sympathetic and Parasympathetic Preganglionic Motoneurons and their Spinal Cord and Brainstem Control Mechanisms

3. Some principles of the spinal organization of the sympathetic preganglionic outflow
   J.B. Cabot (Stony Brook, NY, USA)................................................................. 29

4. Spinal cord reflex organization of sympathetic systems
   W. Jänig (Kiel, Germany).................................................................................. 43

5. Vagal efferent projections: viscerotopy, neurochemistry and effects of vagotomy
   D.A. Hopkins, D. Bieger, J. de Vente and H.W.M. Steinbusch (Halifax, Nova Scotia, St. John’s, Newfoundland, Canada and Maastricht, The Netherlands)......................................................... 79

6. Spinal interneurons and preganglionic neurons in sacral autonomic reflex pathways
   W.C. de Groat, M.A. Vizzard, I. Araki and J. Roppolo (Pittsburgh, PA, USA).................................................................. 97

7. The neuronal control of micturition and its relation to the emotional motor system
   B.F.M. Blok and G. Holstege (Groningen, The Netherlands)......... 113
8. Role of medulla oblongata in generation of sympathetic and vagal outflows  
   P.G. Guyenet, N. Koshiya, D. Huangfu, S.C. Baraban, R.L. Stornetta and Y.-W. Li (Charlottesville, VA, USA) ................................. 127

9. Rostral brain regions contributing to respiratory control  
   R.M. Harper, D. Rector, G. Poe, R.C. Frysinger, M. Kristensen and D. Gozal (Los Angeles, CA, USA) ............................................ 145

Section IV. The Medial Component of the Emotional Motor System uses Diffuse Descending Pathways and Endocrine Systems

10. The ventro-medial medullary projections to spinal motoneurons: ultrastructure, transmitters and functional aspects  
    J.C. Holstege (Rotterdam, The Netherlands) ........................................... 159

11. Serotonin, norepinephrine and associated neuropeptides: effects on somatic motoneuron excitability  
    S.R. White, S.J. Fung, D.A. Jackson and K.M. Imel (Pullman, WA, USA) ................................................................. 183

12. The paraventricular nucleus of the hypothalamus and the functional neuro-anatomy of visceromotor responses to stress  
    P.E. Sawchenko, E.R. Brown, R.K.W. Chan, A. Ericsson, H.-Y. Li, B.L. Roland and K.J. Kovács (San Diego and La Jolla, CA, USA) ................................................................. 201

Section V. Ascending Pathways and their Descending Control Systems

13. An ascending general homeostatic afferent pathway originating in lamina I  
    A.D. Craig (Phoenix, AZ, USA) ............................................................. 225

14. Involvement of the spino-parabrachio-amgdaloid and -hypothalamic pathways in the autonomic and affective emotional aspects of pain  
    J.F. Bernard, H. Bester and J.M. Besson (Paris, France) ..................... 243

15. Somatosensory and visceral input to the hypothalamus and limbic system  
    R. Burstein (Boston, MA, USA) ............................................................. 257

16. Physiological functions of pontomedullary raphe and medial reticular neurons  
    P. Mason and C.G. Leung (Chicago, IL, USA) ......................................... 269

Section VI. The Midbrain as Integrator of Emotional Responses

17. Columnar organization in the midbrain periaqueductal gray and the integration of emotional expression  
    R. Bandler and K.A. Keay (Sydney, NSW, Australia) ......................... 285

18. Midbrain and medullary regulation of defensive cardiovascular functions  
    T.A. Lovick (Birmingham, UK) ............................................................. 301
19. Midbrain and medullary regulation of respiration and vocalization
P.J. Davis, S.P. Zhang and R. Bandler (Lidcombe and Sydney, NSW, Australia) ........................................................................................................315

20. A concept for the final common pathway of vocalization and lordosis behavior in the cat
V.G.J.M. VanderHorst and G. Holstege (Groningen, The Netherlands) ........................................................................................................327

21. Meeting the constraints upon behavioral expression through neural and genomic interactive mechanisms
D.W. Pfaff, X.S. Wu-Peng, R. Scott and Y.-S. Zhu (New York, NY, USA) ........................................................................................................343

22. Olfaction and brainstem circuits of reproductive behavior in the rat
M.T. Shipley, A.Z. Murphy, T.A. Rizvi, M. Ennis and M.M. Behbehani (Baltimore, MD and Cincinnati, OH, USA) ..................................355

23. Role of the locus coeruleus in emotional activation
G. Aston-Jones, J. Rajkowski, P. Kubiak, R.J. Valentino and M.T. Shipley (Philadelphia, PA and Baltimore, MD, USA) ..........................379

24. Functional anatomy of nociceptive neurones in rat superior colliculus
P. Redgrave, S. Telford, S. Wang, J.G. McHaffie and B.E. Stein (Sheffield, UK and Winston-Salem, NC, USA) ........................................403

25. Arousal and locomotion: from schizophrenia to narcolepsy
E. Garcia-Rill, N.B. Reese and R.D. Skinner (Little Rock and Conway, AR, USA) ....................................................................................417

Section VII. Forebrain Circuitry Governing Emotional Responses

J. LeDoux (New York, NY, USA) .................................................................................................................................437

27. The neurobiology of the central nucleus of the amygdala in relation to neuroendocrine and autonomic outflow
B. Bohus, J.M. Koolhaas, P.G.M. Luiten, S.M. Korte, B. Roozenendaal and A. Wiersma (Haren, The Netherlands) ..................................447

28. Theories of basal forebrain organization and the “emotional motor system”
G.F. Alheid and L. Heimer (Charlottesville, VA, USA) ..................................461

29. The nucleus accumbens: gateway for limbic structures to reach the motor system?
H.J. Groenewegen, C.I. Wright and A.V.J. Beijer (Amsterdam, The Netherlands) ....................................................................................485

30. The ascending basal forebrain cholinergic system
K.J. Page and M.V. Sofroniew (Cambridge, UK) ..................................................................................................................513
31. Networks related to the orbital and medial prefrontal cortex; a substrate for emotional behavior?
J.L. Price, S.T. Carmichael and W.C. Drevets (St. Louis, MO, USA)

32. Role of the cerebral cortex and striatum in emotional motor response
C.B. Saper (Boston, MA, USA)

33. The greater limbic system, the emotional motor system and the brain
R. Nieuwenhuys (Nijmegen, The Netherlands)

Section VIII. Clinical Manifestations of Disorders of the Emotional Motor System

34. Hemispheric specialization for emotions, affective aspects of language and communication and the cognitive control of display behaviors in humans
E.D. Ross (Fargo, ND, USA)

35. Clinical observations on the emotional motor system
S.G. Waxman (New Haven, CT, USA)

36. Behavioural complications of limbic epilepsy: implications for an understanding of the emotional motor system in man
M. Trimble (London, UK)

37. Mapping cerebral sites for emotion and emotional expression with direct cortical electrical stimulation and seizure discharges
B. Gordon, J. Hart, Jr., R.P. Lesser and S. Arroyo (Baltimore, MD, USA)

Subject Index